



## **NASA STTR 2005 Phase I Solicitation**

### **T6 Kennedy Space Center**

NASA's launch headquarters, John F. Kennedy Space Center (KSC), is America's gateway to the universe and its busiest launch and landing facility. KSC at the Cape Canaveral Spaceport is NASA's Spaceport Technology Center, a world-class resource for the space transportation industry. KSC is helping to set the standard for future spaceports everywhere. Designers of new space transportation systems and architectures are integrating KSC-developed spaceport and range technologies into those designs to lower not only the costs of building the flight and ground systems but also of maintaining and operating them. Visionary approaches and strategies being developed today at KSC are laying the groundwork for the Cape Canaveral Spaceport and other spaceports and ranges of the future. We want to continue to offer safe and cost-effective space access for our nation and international partners' needs.

## **Subtopics**

### **T6.01 Self-Healing Repair Technologies**

**Lead Center: KSC**

It is highly desirable to develop technologies for polymeric materials used in electrical wire insulation that have the ability to self-heal. One example of self-healing is the repair process for composite materials, which uses the stress induced by a microfissure to rupture microcapsules of repair materials. In this system, a monomer is microencapsulated and then dispersed along with a catalyst. Once the microcapsules rupture, the monomer is polymerized by the dispersed catalyst and the microfissure is filled. Applications for self-healing processes for materials can be found in areas where failures could result in catastrophic consequences. For example, failure of structural members in spacecraft or aircraft; failure of electrical wire insulation materials used in spacecraft, aircraft, or buildings; or failure of polymer membranes used in critical separations in space exploration or medical devices. The key to any self-healing process is to use the change that occurs during the onset of the failure to initiate the repair process. This change could be the result of an impact to the insulation or the beginning of the electrical breakdown of the insulation. What is required would be an action that provided sufficient energy to start a second reaction or process that ultimately produced and/or bonded the repair material to the damaged insulation.

Wire insulation failure is considered a major problem on spacecraft and proposals should support concepts to develop self-healing technologies that have the ability to repair damaged Kapton or Teflon wire insulation. Of particular importance will be the methods needed to induce the self-repair process in wire insulation that has been manufactured. It is important to recognize the impact of the manufacturing process used to produce the insulated

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wire on the final product. These methods must produce a flexible, watertight seal over the damaged area. The physical and chemical properties of the final repair material should be similar to the initial insulating materials.

Proposals are also sought for innovative technologies and technology concepts in combining or bonding self-healing materials to conductor materials for an integrated, advanced, next-generation wiring system. Technologies for advancing conductor materials to allow for this integrated system should be considered since this is a topic area of concern in the Human and Robotic Technology Program.

## **T6.02 Batteryless, Wireless Remote Sensors**

**Lead Center: KSC**

Recently, an innovative communication scheme was demonstrated that increases the attractiveness of using Surface Acoustic Wave (SAW) sensors as the basis for wireless, passive, sensor networks. It now appears feasible that a moderate number of sensors could be distributed throughout a volume of space and interrogated remotely and individually. Such a capability is of interest to the space program in that it may provide a lightweight (no wires and small sensors), low maintenance (no batteries), sensing network that can be used in harsh environments (predicted temperature ranges are from cryogenic through 900° C). NASA is currently funding work on a distributed temperature-sensing network but seeks other advances in this area.

At the recent 2004 IEEE International Ultrasonics, Ferroelectrics, and Frequency Control 50th Anniversary Joint Conference, two papers on Orthogonal Frequency Coding for SAW Sensors were presented. This new communication scheme for SAW devices and sensors appears to offer the capability to develop sensing networks where individual sensors can be interrogated from among a distributed array of devices. It also appears to provide scaling of the system in both number and range while suffering minimal degradation in the time resolution of the echoed signals. Consequently, NASA has recently decided to fund the development of a demonstration system using this concept and using a selected sensor (most likely temperature).

But, further advances are sought in this area, particularly, but not limited to, the area of novel sensors. Both the Space Shuttle as well as future vehicles could benefit from distributed strain sensors allowing high resolution monitoring of airframe stress. Embedded sensors within high pressure dewars might indicate fracturing before destructive failure occurs. Sensors that can operate within a cryogenic environment without the heat loss associated with wires could offer level, pressure, or temperature monitoring capabilities that are difficult or impossible to achieve with current technology. Embedded corrosion sensors or other process monitors could provide useful data. For example, it might be advantageous to locate moisture sensors under the Shuttle's thermal protection system materials. Also, there is interest in distributed leak detection systems, where, for example, hydrogen could be detected before it accumulates to the 4% explosive level in air. In addition to sensor development, improvements to the overall system are sought. For example, improvements are desirable in antenna design or system architecture that increase range or sensitivity.

The goal is to provide new sensors and capabilities that are compatible with the Orthogonal Frequency Coding scheme recently demonstrated under NASA funding in order to increase the range of applicability of this concept.

